Technical Bulletin
Bad Battery Shutdown Prevents Damage during Bad or Missing Battery Conditions

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Phocos North America

Bad batteries or missing batteries can cause damage to solar charge controllers. Controllers are susceptible to specific types of failure when batteries can't maintain a voltage above 9V but the charging function is still on.

Phocos' Bad Battery Shutdown feature automatically adjusts to bad battery conditions, preventing damage to the controller and connected loads until stable battery health is restored. This feature was introduced to PWM solar charge controller families beginning in 2016.

Let's take a closer look at where problems can occur and how Bad Battery Shutdown reduces the risk of damage.

Where Problems Start
When a system is running normally, the solar charge controller manages battery charging by the PV array and manages power from the battery to any DC loads connected to the load terminals. DC loads might include DC lights and appliances.

Problems can start when a battery can't maintain at least 9V or when a battery is disconnected from the controller from an accidental cut in

Phocos began introducing Bad Battery Shutdown to our PWM solar charge controller families in 2016.

wiring or a blown fuse while the controller is charging. (See sidebar *When Batteries Go Bad or Missing* for definitions).

Incorrect Wiring Increases Risk
Incorrect wiring can increase risk of damage to connected DC loads. Loads with high inrush currents such as inverters or DC motors should never be connected to a controller's load terminals.

When loads are connected to the battery bank but not isolated from the controller's battery terminals, fuses and breakers may not protect equipment as intended. (See *Examples of Incorrect and Correct Wiring Diagrams* on pages 2 and 3).

Without Bad Battery Shutdown
For example, if a battery is suddenly disconnected due to a loose

When Batteries Go Bad or Missing

A "bad battery" cannot maintain a normal voltage and has lost capacity. This happens over time with normal age and use, and it happens when batteries are subjected to adverse conditions like discharging a battery excessively in very cold environments, use in very hot environments, or insufficient charging. In lead acid batteries, damage is known as sulfation.

A "missing battery" is one that may be electrically isolated from the system by a blown fuse, tripped breaker or physically disconnected wire.

wire and the controller is trying to charge, the battery terminal voltage instantly jumps to the PV open-circuit voltage. Without Bad Battery Shutdown, the controller tries to keep the battery voltage at a normal level by applying special switching algorithms.

When this happens, there are high power losses that can damage most PWM controllers.

Loads connected to the controller load terminals may also be damaged. If the loads are powered on when this happens, the voltage and current may exceed any built-in electronic protections of connected devices.

With Bad Battery Shutdown
Using the same example of a loose wire that disconnects the battery, Phocos' PWM Solar Charge Controllers detect bad battery conditions and automatically switch off charging and load power immediately and wait until the battery voltage reaches at least 9V before trying to switch charging on again.

This prevents the high power loss and protects the controller from damage. It also provides additional protection for connected loads.

Result: Improved Reliability
Bad Battery Shutdown improves battery voltage measurement accuracy at voltages less than 9V.

The benefit of Bad Battery Shutdown is improved reliability without a change in core functionality when best practices for battery maintenance or wiring are not followed.

To find out in your Phocos PWM controller has Bad Battery Shutdown or to confirm this feature prior to purchase, please contact the Phocos Technical Department at 520.777.7906 option 2 or email us at tech.na@phocos.com.

Examples of Incorrect and Correct Wiring Diagrams

Example 1
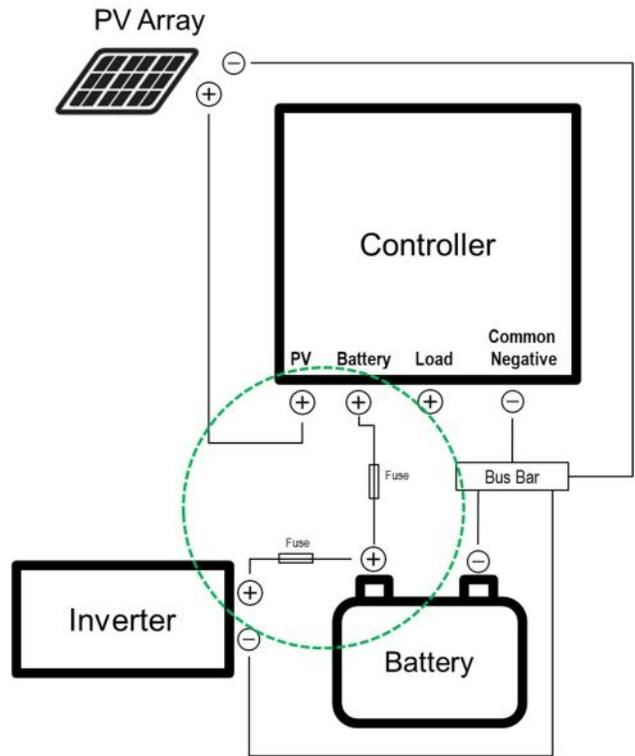**Incorrect Wiring with Inverter Not Isolated**

In this example the inverter is not isolated from the controller's battery terminals if the battery fuse is blown.

There is a high probability of inverter damage during bad or missing battery conditions without Bad Battery Shutdown.
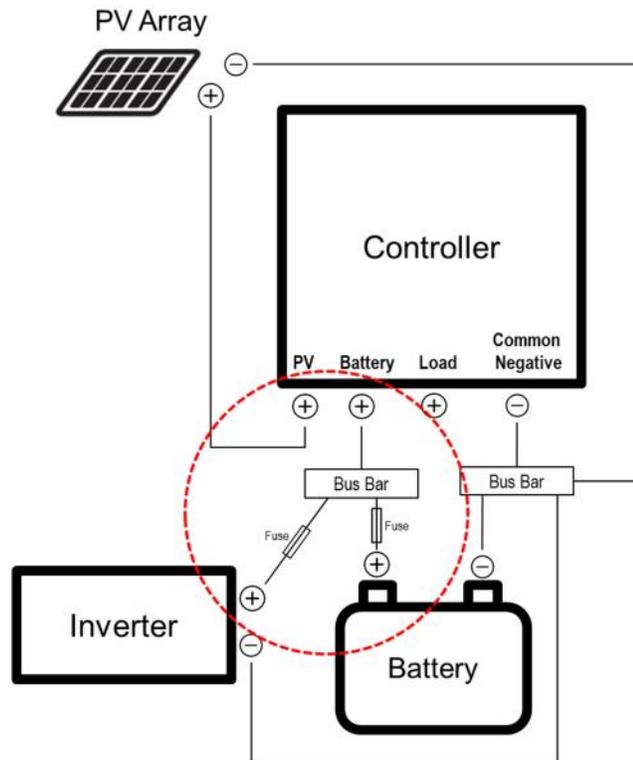
Example 1
Correct Wiring with Inverter Isolated

This is the recommended configuration for the inverter to be isolated from the controller's battery terminals.

Example 2
Incorrect Wiring with Inverter Connected to the Controller Load Terminals

Inverters should always be connected directly to a battery bank and never connected to the load terminals of a controller. High inrush currents could damage the controller.

If best practices in wiring are not followed, Bad Battery Shutdown still protects against damage in some cases.